



# A Guide for Composites Fabrication Operations

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*If you need this information in an alternate format, please call the Hazardous Waste and Toxics Reduction Program at 360-407-6700. If you are a person with a speech or hearing impairment, call 711, or 800-833-6388 for TTY.*

# Why should composites fabricators pay attention to their products and wastes?



Composites fabricators across Washington State regularly use products that are hazardous to workers. For example, the laminating process uses resins and initiators that are flammable. Tool clean-up also often involves using a flammable solvent, like acetone.

Composites fabrication activities also generate a steady stream of potentially hazardous air emissions, spent solvents, and other wastes that can impact the environment. With hundreds of composites fabricators in the state, it is important that each one do their part to minimize impacts to human health and the environment.

This means that you play an important role! By correctly managing your wastes, you will ensure that you are in compliance with federal, state and local environmental regulations and avoid costly penalties. Better yet, by *reducing* your use of hazardous products and generation of wastes, you can:

- ✓ Reduce the costs for waste disposal, permits, and materials management.
- ✓ Reduce administrative, compliance-related costs by dropping below regulatory thresholds for reporting.
- ✓ Gain customers who know they have made a wise choice in selecting a business that helps protect the environment.

# What regulations typically apply to composites fabrication operations?



A number of regulations can apply to composites fabrication operations. These regulations stem from the types of products used and types of wastes generated by the industry. Table A lists typical composites fabrication processes, products and wastes. The regulations referenced in the table protect worker health and safety, community rights, and the environment.

## **Worker Health & Safety**

The state's Department of Labor and Industries implements worker health and safety regulations. If you employ one or more people in your shop, you must ensure that:

- ✓ Workers have access to appropriate safety and protective gear, like gloves and respirators.
- ✓ Workers understand any hazards associated with their job. Hazardous products must be identified and labeled, and information about the product must be kept on-site.
- ✓ Workers are not exposed to excessive levels of air-borne pollutants, like styrene.

Labor and Industries has an assistance program to help you understand health and safety issues. Contact them at (800) 423-7233, or contact your nearest L&I regional office. You can find contact information for the L&I office locations at <http://www.lni.wa.gov/home/direct.htm>. To find out more about this consultation program, see L&I's consultation web page at [http://www.lni.wa.gov/wisha/consultation/consultation\\_info.htm](http://www.lni.wa.gov/wisha/consultation/consultation_info.htm).

# Table A -- Typical Composites Fabrication Processes, Products Used and Wastes

Process & Primary Products Used <sup>1</sup>	Primary Wastes
<p><b>MOLD PREPARATION</b>  <b>Release Agent</b> – Nonhazardous wax or polymer.</p>	<p><b>Dirty Rags</b> – <i>Hazardous</i> if contaminated with certain solvents. Can be recycled by approved laundry.</p>
<p><b>GEL COATING, LAMINATING</b>  <b>Resin</b> – Often <i>hazardous</i> because it is flammable and contains styrene monomers.</p> <p><b>Initiators</b> – Often <i>hazardous</i> because they're flammable and reactive due to peroxide content.</p> <p><b>Reinforcement</b> – Nonhazardous glass fiber; aramid and carbon fibers are also sometimes used.</p>	<p><b>Air Emissions</b> – Styrene and other volatile organic compounds (VOCs) are commonly regulated by local air authorities.</p> <p><b>Spent Solvent &amp; Still Bottoms</b><sup>2</sup>  Often <i>hazardous</i> if the solvent product was flammable or toxic. Nonhazardous waterbase wastes are often disposed through local sewer (contact local sewer utility first).</p> <p><b>Overspray Solids, Trim-ends, &amp; Cut-outs</b> – Nonhazardous; often disposed in landfill.</p>
<p><b>TOOL &amp; EQUIPMENT CLEAN-UP</b>  <b>Solvent</b> – Often <i>hazardous</i> because of low flash point or chlorine content. Acetone, toluene, xylene, and various alcohols are flammable. Emulsifiers and citrus-based solvents may be toxic, and chlorinated solvents are toxic.</p>	

1 – If the product is referenced as being *hazardous*, then regulations may apply to worker health and safety, fire risk, and "Community Right-to-Know."

2 – Spent solvent is often distilled on-site which results in a reusable liquid solvent and solid "still bottom." Liquid wastes and still bottoms may be regulated by the state's *Dangerous Waste Regulations*. Water quality standards may also apply; if nonhazardous waste is to be discharged to the sewer system, the local sewer utility should be contacted first.

## **Worker Safety — Fire Risk**

Local fire codes regulate flammable products, like acetone and resins. These codes define how much product you can have on site. They also define how products should be stored and/or “processed” in your shop. For example, peroxide initiators must be stored in a fire-resistant cabinet. Fire code standards for composites fabrication operations are specified in a National Fire Protection Association (NFPA) document - NFPA 33, Chapter 15. Contact your local fire marshal to determine which, if any, fire codes apply to your shop.

## **Community Right-to-Know**

Title III of the Superfund Amendments and Reauthorization Act (SARA), known as the “Community Right-to-Know” law, requires businesses to report their use of hazardous chemicals.

This federal law may affect your shop if you use over 10,000 lbs of any solvent and/or over 50,000 lbs of resin per year. Acetone was recently removed from SARA’s regulated list, but other solvents like N-methylpyrrolidine, methylene chloride, toluene and xylene remain “listed” and are regulated.

Contact the Department of Ecology’s Hazardous Substance Information Office at (800) 633-7585 or e-mail them at [hsio@ecy.wa.gov](mailto:hsio@ecy.wa.gov) to see if your shop is regulated by this law. You can also obtain a list of the affected chemicals and associated reporting requirements by visiting the Environmental Protection Agency’s (EPA) TRI (Toxics Release Inventory) web site at <http://www.epa.gov/tri/>.

## **Air Emissions**

The Department of Ecology or local air agencies regulate businesses that release volatile organic compounds (VOCs) and/or toxic air pollutants (TAPs). These compounds can create smog, damage the Earth’s ozone layer, impact human health and affect the environment. In your shop, you may be able to smell VOCs in the form of styrene or solvent emissions.

Composites fabricators must obtain an air operating permit if they emit 10 tons or more of any one federally designated

hazardous air pollutant (HAP) like styrene, or 25 tons or more of all HAPs combined, and/or 100 tons of any regulated pollutant such as volatile organic compounds. Boat makers that need a permit must comply with the boat MACT (maximum achievable control technology). More information about this rule can be obtained at EPA's boat MACT web site at <http://www.epa.gov/ttn/atw/boat/boatpg.html>. Other fiber-reinforced plastic (FRP) fabricators needing a permit must comply with the Reinforced Plastic Composites (RPC) MACT. More information on this rule can be obtained at EPA's RPC MACT web site at <http://www.epa.gov/ttn/atw/rpc/rpcpg.html>. More information about air emissions for the FRP industry can be found on American Composites Manufacturers Association's (ACMA's) web site at <http://www.acmanet.org/ga/emissionsopenmolding.cfm>.

All composites fabricators are required to meet state and local regulations that require, among other things, registration and reasonable precautions to control odors and fugitive dust (see Chapter 173-400 WAC and local regulations for more information). In addition, businesses that plan to modify, build or expand their operation should check with their local air agency to determine if a "new source" review permit is necessary. Contact information for local air agencies is listed at the end of this guide.

## **Solid Wastes**

Overspray solids, unused (cured) products, catalyzed resins which harden during use, trim-ends and cut-outs typically are not regulated as hazardous waste. However, some landfills do impose restrictions on pick-up and disposal. Contact your local landfill to determine if restrictions apply.

## **Water Releases**

Spent solvents or other wastes should never drain onto the ground or into a septic system, stormdrain, surface water or any other drain not connected to a sanitary sewer. This type of improper disposal can have an adverse affect on ground-

water, surface water and sediments.

Contact your local sewer district to determine if your wastewater can be discharged to a sewer collection system. The sewer district will determine if your wastewater is acceptable for treatment at a local sewer plant.

Businesses that plan to build or expand should check with the Department of Ecology's Water Quality Program to determine if they need a discharge permit. A permit also may be required if activities take place outside where pollutants could leave the site in stormwater runoff. Contact the closest Ecology Regional Office with questions. Contact information is listed at the end of this guide. More information is available on Ecology's Water Quality web site at <http://www.ecy.wa.gov/programs/wq/permits/index.html>.

## **Hazardous Wastes**

Some composites fabrication wastes are regulated because they are hazardous. For example, spent acetone is regulated because it is ignitable, and spent emulsifier is sometimes regulated because it is toxic to fish.

The State's *Dangerous Waste Regulations* (Chapter 173-303 WAC) define the different types of hazardous wastes. They also regulate the generation, storage, treatment, disposal and transport of these wastes. The regulations also apply to the recycling of hazardous waste.

Businesses that generate more than 220 lbs of hazardous waste per month (about half a 55-gallon drum) are regulated by Ecology's Hazardous Waste and Toxics Reduction Program. These businesses need to obtain a RCRA (Resource Conservation and Recovery Act) Identification Number, and should contact Ecology for more information about the regulations (see Ecology contact information at the end of this guide). Additional information about hazardous waste regulations in Washington State can be found at Ecology's Hazardous Waste and Toxics Reduction web site at <http://www.ecy.wa.gov/programs/hwtr/>.

Businesses that generate less than 220 pounds of dangerous



waste are regulated by local government Moderate Risk Waste (MRW) Programs. These programs provide assistance to small quantity generators, and can help guide the proper disposal of hazardous wastes. County MRW Program contact information is available on Ecology's web site at <http://www.ecy.wa.gov/biblio/0007013.html>.

If you have any amount of leftover liquid catalyzed resins, you must handle the leftover liquid as hazardous waste. Spreading out the resin for cooling is a treatment method that must be conducted according to Ecology's Technical Information Memorandum *Treatment by Generator*, publication #96-412. Placing the liquid in a water bath may result in a contaminated wastewater that must be analyzed prior to disposal. Catalyzing unused resins for disposal are also regulated under *Treatment by Generator*. Count all these liquids towards your monthly hazardous waste generation totals and report them on your annual generator report.

## How can composites fabricators most effectively deal with regulations?



By reducing or eliminating hazardous materials, you can save time, effort and money spent to comply with regulations. You may be able to reduce your regulatory burden by **preventing pollution**. By moving to the source of problems you can:

- ✓ Reduce your use of hazardous products and your generation of wastes.
- ✓ Improve worker health and safety.
- ✓ Reduce costs associated with waste management and product purchases.
- ✓ Reduce fire hazards, spill problems, and other liabilities.

Many composites fabricators have found that it isn't as hard to prevent pollution as they thought. Try using the following four-step process:

1. Walk through your shop and determine where hazardous products are used and where wastes are generated. Table A lists some of those sources.
2. Review your operating practices and line operations, then match them to the reduction or recycling options offered later in this guide. Ask these key questions:
  - \* *Where can I reduce the use of hazardous products?* Could alternative, less hazardous products be used?
  - \* *How can I reduce my waste?* Could air emissions, evaporation losses, or spills and leaks be reduced?
  - \* *What waste can I recycle?* Could waste solvent be distilled, or solid wastes reused? Recycling waste is much better than sending it to be burned or landfilled, but it is less beneficial than reducing it. A lot of resources are required to properly collect and manage wastes for recycling. Those resources and costs can be cut by reducing the amount of waste generated in the first place.
3. Evaluate pollution prevention opportunities for their technical and economic merit. Does the “new” solvent work in each application? Do workers accept the change? Is it affordable, or worth the cost because it results in reduced risk or improved quality?
4. Set goals and timelines to help keep you on target. How will the changes save money or improve quality? And, when can you expect results?

For composites fabrication facilities that meet certain thresholds of hazardous material use and/or hazardous waste generation, pollution prevention (P2) plans are required, which include the steps above. To find out more about this program, see Ecology’s P2 Planning web page at <http://www.ecy.wa.gov/programs/hwtr/p2/p3.html>.

## Can you improve your operating practices?



Good operating practices cannot only help prevent pollution, they can help you comply with various regulations. Use the following checklist to review your operating practices.

### Storage and Housekeeping

- ☐ Keep lids on products and wastes, and store them so they can be easily inspected for leaks.
- ☐ Keep labels on products and wastes to quickly identify them and to prevent accidental mixing.
- ☐ Use curbs, pans or buckets to catch any possible leaks or spills.
- ☐ Keep work areas and walkways free of tripping hazards and obstructions.
- ☐ Stack containers so they can't tip, puncture or break.
- ☐ Store empty drums and containers in a place where they WON'T collect rainwater.

### Inventory Control

- ☐ Have Material Safety Data Sheets available in case of an emergency.
- ☐ Buy and store only the amount of product that is needed.
- ☐ Purchase products in rinsable, recyclable containers with a minimal amount of packaging.
- ☐ Ration solvents or other products to minimize use.

## **Training and Awareness**

- ☐ Train workers about regulations, emergency procedures, health and safety issues, and reduction alternatives.
- ☐ Follow routine procedures for mixing, transferring, and applying gel coats and laminates, and for cleaning tools.
- ☐ Use proper insulation of electric circuitry and inspect it regularly.
- ☐ Have first aid supplies, spill equipment, and emergency phone numbers accessible for use.
- ☐ Have respirators, gloves, and other personal protective gear available to workers.

## **Information Resources**

- ☐ Contact vendors to determine which products are hazardous and to find other, less hazardous products.
- ☐ Contact trade groups to get the most current information about composites fabricator's issues. Contact information is provided at the end of this guide.
- ☐ Contact regulatory authorities to determine which laws apply and to get assistance. Contact information is provided at the end of this guide.

## **Can you improve your gel coating and/or laminating activities?**



There are many possible reduction opportunities for gel coating and laminating, primarily focused on reducing the use of resins and initiators and generation of air emissions.

## **Spray Guns**

Reduce overspray and the amount of product used by:

- ☐ Employing controlled spraying methods that include: setting up the spray gun at the lowest workable pressure; incorporating perimeter flanges on molds to reduce overspray; and providing operator training that includes proper spray gun handling.
- ☐ Using the newest non-atomizing applicators in place of air atomized spray guns.

## **Resins**

Reduce emissions and resin volume by:

- ☐ Using inert filler in resins.

## **Process Controls**

Reduce product use and emissions by:

- ☐ Installing process monitoring equipment.
- ☐ Reducing laminate thickness to engineered minimum.
- ☐ Maintaining minimum gel times and adequately heating process area.

## **Alternative Processes**

Reduce emissions and product use by:

- ☐ Installing closed molding systems such as vacuum infusion processing (VIP) or resin transfer molding (RTM).
- ☐ Installing an impregnator system.
- ☐ Using vacuum-formed thermoplastic (i.e., acrylic or ABS) sheet to replace gel coat finish.

## **Alternative Resins**

Reduce emissions and product use by using:

- ☐ Resin and gel coat with lower HAP content.
- ☐ Heat to reduce resin or gel coat viscosity and resulting spray pressure.
- ☐ Vapor suppressant additives in resin.
- ☐ UV curing.
- ☐ Non-HAP containing resins, such as epoxy.

## **Can you improve your tool & equipment clean-up activities?**



Rollers, transfer hoses, drums, spray guns, and other tools and equipment that come into contact with resins must be solvent washed immediately after each run to avoid polymerization. Historically, acetone was the solvent of choice, but recently other solvents like emulsifiers and citrus-based cleaners have gained in popularity. [After acetone was “delisted” from the TRI list (see Community Right-to-Know section of this guide), some fabricators switched back to acetone. However, the information below in the “Use and Practice” and “Waste Management” sections still applies.]

Ecology’s Toxics Reduction Unit, product vendors, and trade groups can offer more information about pollution prevention alternatives (see the back of this guide for contact information), including the following:

### **Use and Practice**

- ☐ Allow solvent to become dirtier before disposing or recycling.
- ☐ Install additional spray lines to reduce the need for clean-out.

- ☐ Install disposable liners in buckets.
- ☐ Install gun cleaning tank/unit.
- ☐ Install two-bucket wash; one clean and one dirty.
- ☐ Keep lids on soaking buckets.
- ☐ Ration solvent or other material.
- ☐ Reduce the number of cleaning buckets distributed to operators.
- ☐ Remove solid resin by hand prior to solvent wash.
- ☐ Use disposable rollers or brushes.

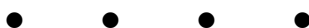
### **Alternatives to Acetone Use**

- ☐ Emulsifiers.
- ☐ Uncatalyzed resin to flush lines.

### **Reuse of Materials**

- ☐ Decant and reuse spent solvent.
- ☐ Install on-site distillation unit, and then grind and reuse still bottoms in “putty” (bottoms must contain less than 2% solvent without “air-drying”).
- ☐ Separate and reuse scrap (cured) composite materials.

## **Common Definitions**



Every industry has its own jargon that is shared by those who work or serve that industry. The composites fabrication industry is no exception. The following defines some of the key terms used by this group:

## ***BPO***

“Benzoyl Peroxide” initiator used for curing unsaturated polyester and vinyl ester resins at elevated temperatures.

## ***Closed Molding***

Process using two matched molds to render a good inside and outside surface.

## ***Curing***

A polymerization process transforming liquid resin to a solid, creating the maximum physical properties attainable from the materials.

## ***FRP***

“Fiber Reinforced Plastics.”

## ***Gel coating***

Colored or clear resin is sprayed, along with initiator to the most visible surface of the object being manufactured. Gel coating provides a cosmetic, often shiny surface and environmental protection for the fiberglass laminate.

## ***Hand Lay-up (laminating)***

Initiated resin is applied to roll stock reinforcement (i.e., chopped strand mat, woven or knitted fabric). The resin may be applied manually (bucket and brush) or by spray gun. Successive layers of resin and fiber are added until the desired product thickness is achieved. Once the reinforcement is in place, hand rollers are used to remove voids, smooth the surface and insure proper integration of resin and reinforcing material.

## ***Initiator***

Substance added to gel coat or resin to initiate the curing, or cross-linking, process.



### ***MEKP***

“Methyl Ethyl Ketone Peroxide” is the most popular initiator in use in the industry. It is a clear colorless liquid with a slightly pungent odor and is a potential reactive hazard. It is incompatible with very strong acids, bases, and oxidizers, and presents various potential health hazards.

### ***Non-Atomized Application***

The application of a thermoset resin to a fiber reinforcement using a fluid delivery device, including flow coaters, flow choppers, pressure fed rollers, or other non-spray applicators.

### ***Open Molding***

An open mold provides a surface for applying “sprayed lay-up” or “hand lay-up” materials.

### ***Prepreg Fiber Reinforcement***

“Prepregs” are presaturated with resin and allow for close control of fiber to resin ratios, reduced air emissions, and reduced clean-up and disposal of wastes.

### ***Resin***

Either natural or synthetic products, generally having high molecular weight. Most uncured resins used in open molding are liquids. Generally, resins are used to surround, cross-link, and hold fibers to create a composite material with high mechanical properties.

### ***RTM***

“Resin Transfer Molding” is carried out in a closed mold at room temperature. Gel coat is applied to one or both sides of the mold, and reinforcing materials are placed in the bottom half of the mold. The mold halves are closed and clamped, and initiated resin is injected into the mold.

## **SCRIMP**

“Seemann Composite Resin Infusion Molding Process,” a variant of the vacuum infusion process that provides high fiber to resin ratios with virtual elimination of air entrapment and void.

## ***Sprayed Lay-up (laminating)***

An open molding process that uses a spray gun or flow coater to deposit initiated resin and chopped glass (or other type) fibers on the mold or gel coat surface.

## ***Styrene***

An unsaturated hydrocarbon used in plastics. In polyester resin it serves as a solvent and as a co-reactant in the polymerization process that occurs during curing.

## ***Vacuum Bag Molding***

After gel coat, reinforcement and resin is applied to mold, the exposed area is covered with plastics which are sealed to the edges of the mold. Before the resin begins to cure, a vacuum is drawn through the system. The vacuum ensures full distribution of resin, labor is reduced (no rolling), and emissions and other wastes are reduced.

## ***Vacuum Infusion Process (VIP)***

A variation of vacuum bagging where the resin is introduced into the mold after the vacuum has pulled the bag down and compacted the laminate. The reinforcement and core material are laid-up dry in the mold. Vacuum infusion can produce laminates with a uniform degree of consolidation, producing high strength, lightweight structures. This process uses the same low cost tooling as open molding and requires minimal equipment. Very large structures can be fabricated using this method. Vacuum infusion offers a substantial emissions reduction compared to either open molding or wet lay-up vacuum bagging.

# Resources and Contacts



## Trade Groups

**American Composites Mfs. Assoc.**  
1010 N Glebe Rd #450  
Arlington VA 22201  
Phone: (703) 525-0511  
Fax: (703) 525-0743  
Website: <http://www.acmanet.org/>  
Contact: Larry Craigie, Manager  
Technical Services  
[lcraigie@acmanet.org](mailto:lcraigie@acmanet.org)

**National Marine Mfg. Assoc.**  
200 E Randolph Dr #5100  
Chicago IL 60601  
Phone: (202) 721-1604  
Website: <http://www.nmma.org>  
Contact: John McKnight  
Environmental Affairs  
[jmcknight@nmma.org](mailto:jmcknight@nmma.org)

**OR/WA Reinforced Plastics Assoc.**  
3434 SW Water Ave  
Portland OR 97201  
Phone: (503) 228-3387  
Fax: (503) 228-3388  
Contact: Jim Watts

## Air Agencies

**Benton County  
Clean Air Agency**  
Benton County  
(509) 943-3396  
[email@bcaa.net](mailto:email@bcaa.net)  
<http://www.bcaa.net/>

**Olympic Region Clean  
Air Agency**  
Clallam, Grays Harbor,  
Jefferson, Mason, Pacific  
& Thurston Counties  
(360) 586-1044; (800) 422-5623  
Fax: (360) 491-6308  
[info@orcaa.org](mailto:info@orcaa.org)  
<http://www.orcaa.org/>

**Northwest Air Pollution  
Authority**  
Island, Skagit & Whatcom  
Counties  
(360) 428-1617; (800) 622-4627  
<http://www.nwair.org/>

**Puget Sound Clean Air  
Agency**  
King, Kitsap, Pierce,  
& Snohomish Counties  
(206) 343-8800; (800) 552-3565  
Fax: (206) 343-7522  
<http://www.pscleanair.org/>

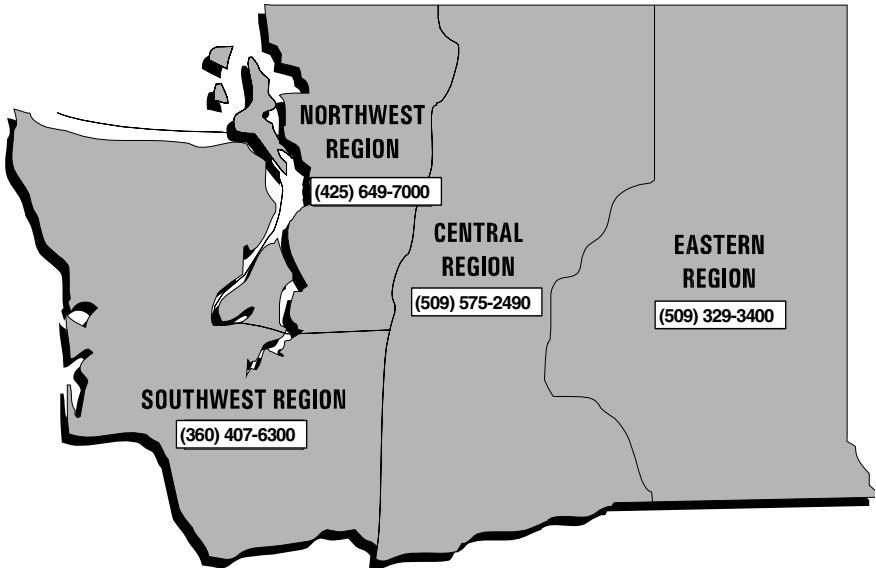
**Southwest Clean Air Agency**  
Clark, Cowlitz, Lewis, Skamania,  
and Wahkiakum Counties  
(360) 574-3058; (800) 633-0709  
Fax: (360) 576-0925  
<http://www.swcleanair.org/>

**Spokane County Air Pollution  
Control Agency**  
Spokane County  
(509) 477-4727  
Fax: (509) 477-6828  
<http://www.scapca.org/>

**Yakima Regional Clean Air Agency**  
Yakima County  
(509) 574-1410; (800) 540-6950  
<http://co.yakima.wa.us/cleanair/>

## Department of Ecology Contacts

For information and assistance about regulatory issues or pollution prevention, contact the nearest Ecology regional office and ask for the program (water, air, or waste), or explain your question and you'll be routed to the best staff person. These numbers can also be used to obtain more information about local **Moderate Risk Waste Programs**.



**Eastern Regional Office**  
North 4601 Monroe, Ste 202  
Spokane, WA 99205-1295  
(509) 329-3400

**Central Regional Office**  
15 W Yakima Ave #200  
Yakima, WA 98902-3452  
(509) 575-2490

**Southwest Regional Office**  
Post Office Box 47775  
Olympia, WA 98504-4775  
(360) 407-6300

**Northwest Regional Office**  
3190 160th Ave. SE.  
Bellevue, WA 98008-5452  
(425) 649-7000